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Title: Hypothetical Facility Data Book: The Shapash Nuclear Research Institute (SNRI)

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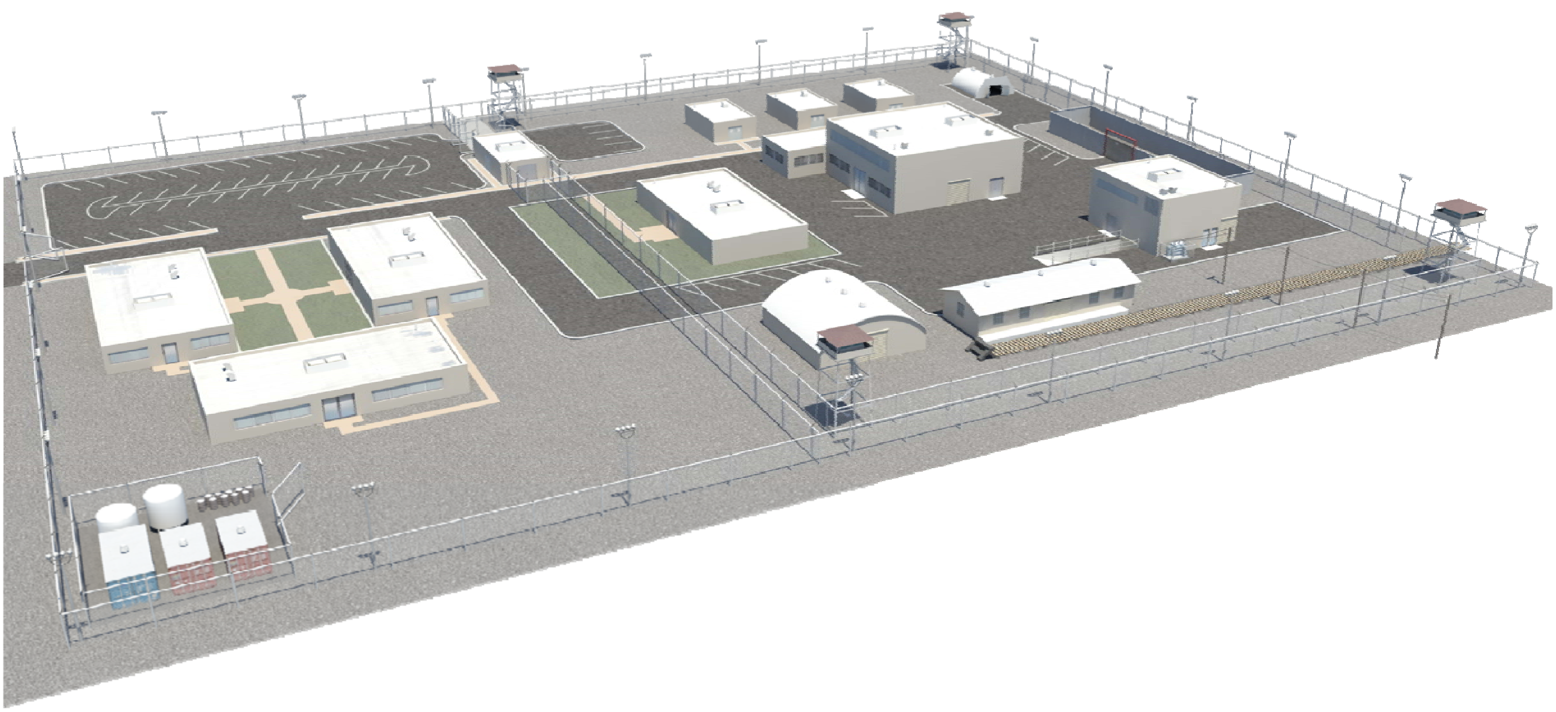
The Shapash Nuclear Research Institute (SNRI)



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Contents

Figures

Tables

Acronyms

AA	Administrative Area
ACB	Access Control Building
ACP	Access Control Point
BMS	Balanced Magnetic Switch
BOP	Behavioral Observation Program
CAS	Central Alarm Station
cm	Centimeter
DA	Destructive Analysis
HEPA	High Efficiency Particulate Air
HEU	Highly Enriched Uranium
HVAC	Heating, Ventilation, and Air -Conditioning
IAEA	International Atomic Energy Agency
ICL	Inventory Control Location
INFCIRC	IAEA Information Circular
kg	Kilogram
KMP	Key Measurement Point
SNRI	Shapash Nuclear Research Institute
LEID	Limit of Error of Inventory Difference
m	Meter
MBA	Material Balance Area
MC&A	Material Control and Accounting
NDA	Nondestructive Analysis
NM	Nuclear Material
NPT	Nuclear Non-Proliferation Treaty (Treaty on the Non-Proliferation of Nuclear Weapons)
PA	Protected Area
PIR	Passive Infrared
QA	Quality Assurance
SNM	Special Nuclear Material
SRT	Special Response Team
TID	Tamper Indicating Device
UO_2	Uranium Dioxide
UPS	Uninterruptible Power Supply
URC	Unacceptable Radiological Consequence
VIP	Very Important Person

Design Basis Threat Overview

The specific threats to be addressed by the workshop for the Shapash Nuclear Research Institute (SNRI) are a

- single, active, nonviolent insider attempting a covert abrupt theft,
- single, active, nonviolent insider attempting a covert protracted theft, and
- single, active, nonviolent insider attempting an act of sabotage with unacceptable radiological consequences (URCs).

Insider threats may come from any level (e.g., management, operational support, administrative support, maintenance, janitorial staff, health physics, data processors, and protective forces).

Active, Nonviolent Insider: Can act alone or in collusion with outside adversaries. This insider can provide information and/or use authorized access, authority, or knowledge, in addition to stealth and deceit, to defeat SNRI elements. The active, nonviolent insider may attempt an abrupt theft, a protracted theft, or a protracted diversion to an unauthorized location (abrupt theft from the SNRI). The active, nonviolent insider can and will ignore security/safety alarms, will open doors, will set off operational alarms, etc. It should be assumed that such insiders would abort their actions if there were a high probability of being identified (i.e., they may risk detection but not identification).

Probability of Sensing (P_S):

During the course, when discussing probability of sensing, the following characterizations are used:

Very High (VH)	Sensing (detection) is nearly guaranteed. At least two simultaneous sensing methods exist.
High (H)	Sensing (detection) is likely to occur. May be some doubt about the reliability of some element of the system.
Moderate (M)	Sensing (detection) has an average chance of occurring, systems are in place and functional, but reliability may be questionable.
Low (L)	Sensing (detection) system is functional but not likely to detect. Systems are not reliable. Methods available to bypass or defeat system.
Very Low (VL)	Very little or no chance of sensing (detection). No system in place or very low reliability.

Probability of Assessment (P_a):

During the course, when discussing probability of assessment, the following characterizations are used:

Very High (VH)	Assessment likely to happen, either by reliable technical means or by personnel in a timely fashion.
High (H)	Assessment likely to occur, but not as effectively.
Moderate (M)	Assessment may occur but may be delayed to the point where it affects response.
Low (L)	Assessment may not occur. System has high susceptibility to deceit or defeat.
Very Low (VL)	Assessment will very likely not occur.

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1.0 General Site Overview

1.1 Location Description

The hypothetical nuclear research center, Shapash Nuclear Research Institute (SNRI), was started in 1950 to serve as the Republic of Anshar's premier nuclear energy research facility. The institute houses various research, fuel fabrication, administrative, and plant support facilities. The SNRI is located in the Republic of Anshar (see Figure 1-1), ~29 km (18 miles) east of Utu—the nation's capital. The reactor at SNRI runs on uranium oxide fuel and performs research on many types of material.

Utu, the capital of Anshar, is an ancient city that arose from the crossroads of early trading lanes. Today, the city is a modern metropolis of two million inhabitants. Utu contains major roadways, a rail system, both a private and military airport, and a limited waterway.

Figure 1-1. Map of the Republic of Anshar.

The SNRI is located in a semi-arid environment. The vegetation consists of small shrubs, cacti, hardy desert trees, and grass. Small animals, such as rabbits, squirrels, prairie dogs, and coyotes, inhabit the area. Birds of all sizes are also present. The climate is a typical high-desert environment, with approximately 300 clear days of bright sunshine per year. On cloudy days, some areas have a high light-to-dark ratio because of moving cloud shadows. Rainfall is ~15 cm per year, with the majority occurring during seasonal thunderstorms in the late July–August rainy season. The spring is typically very windy for 2 to 3 months, with continuous winds of 2–5 kph and gusts of up to 50 kph. Dry debris, dust, and dead vegetation are blown about during the windy season.

The Republic of Anshar is a signatory to the Treaty on the Non-Proliferation of Nuclear Weapons (NPT). This republic has an agreement with the International Atomic Energy Agency (IAEA), which is modeled under the IAEA Information Circular (INFCIRC)/153 corrected. Anshar has not yet completed an Additional Protocol agreement with the IAEA (INFCIRC/540).

1.2 Site Description

The main function of the SNRI is nuclear reactor research. The SNRI fabricates the fuel on site for this reactor. The SNRI also produces fuel for other facilities. The site is divided into two main areas. The first is the low-security Administration Area (AA), where much of the nonproduction activities take place. This low-security area contains the administration building, tech support buildings, and the Radioactive Waste Site. Approximately 20% of the staff works in the AA. The second area is the Protected Area (PA). This very high-security area contains the Research Reactor Building, Fuel Fabrication Building, support buildings, Oxide Storage Bunker, the road and rail transportation terminus, and the main cafeteria. The simplified area diagram shown in Figure 1-2 illustrates the major facilities of the SNRI.

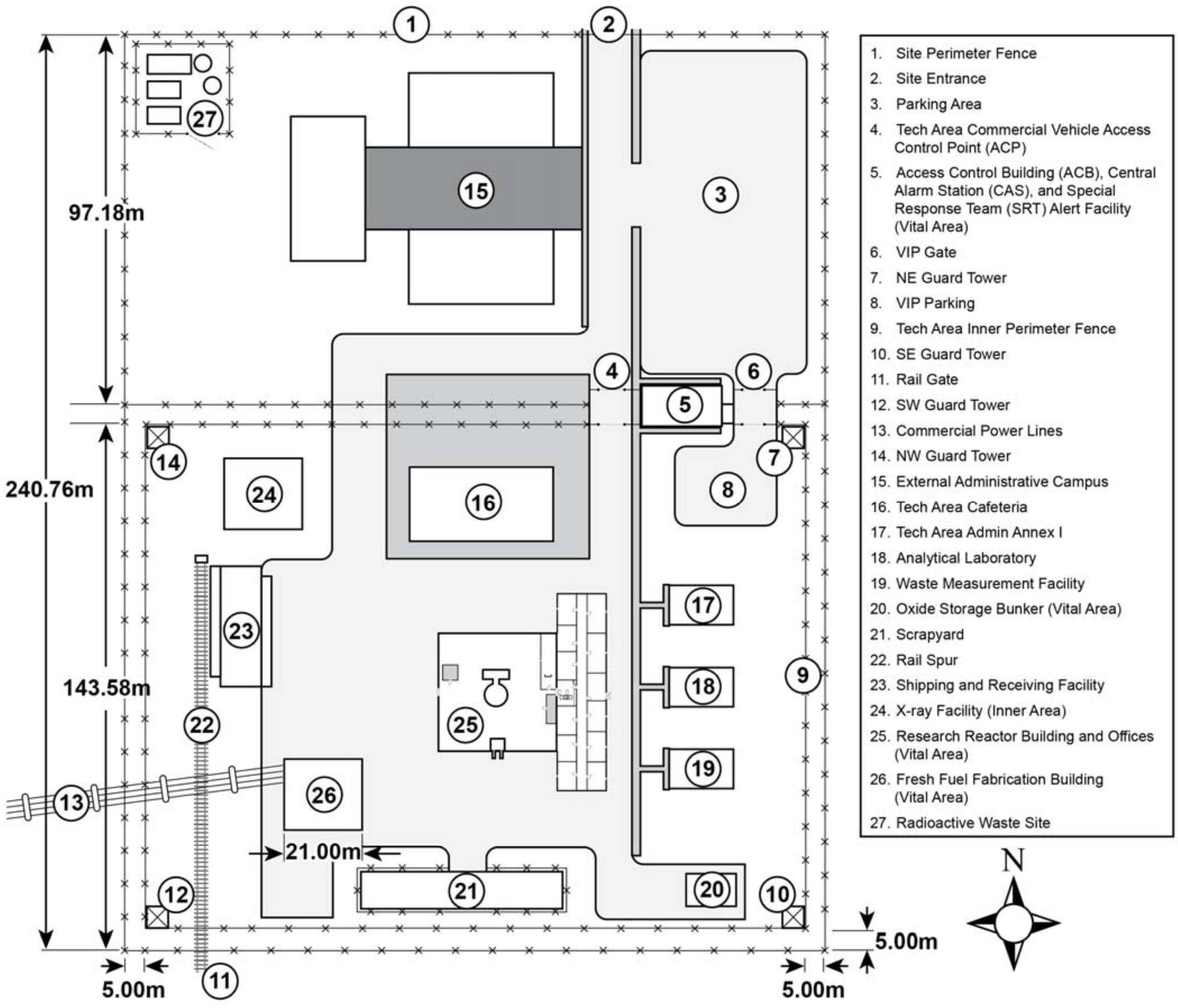


Figure 1-2. SNRI site layout.

1.3 Administrative Area

The northern two-fifths of the SNRI site is the AA. This area is surrounded by a fence along three sides—known as the North Fence—and the PA fence along the southern side. The North Fence is 2.5 meters (m) high and is constructed of standard chain-link fabric fastened to metal poles. The site entrance gate (located on the north side of the site) is unlocked and open during normal working hours and is locked during off-hours. During these off-hours, personnel needing to enter the site must phone the guard in the Central Alarm Station (CAS) from a telephone at the gate. A guard is then dispatched to the gate to check the requester's badge. Possession of a valid site badge is the only requirement for off-hour access.

The buildings in the AA are not alarmed and are unlocked during business hours (0700–1800). Most senior management has keys to the outer doors of these buildings. Personnel have keys to their specific work areas. Personnel needing off-hour access to the buildings notify the guard, who opens the gate, escorts them to the building, and lets them in. When the personnel leave the building, they must inform the guard that they are vacating the building. The doors lock automatically behind the departing employee. The guard meets the employees at the gate to let them off site. All keys are controlled by the guard force and are stamped "Do Not Duplicate."

The Radioactive Waste Site is located within the AA at the northwest corner of the SNRI site. The Radioactive Waste Site is an IAEA Category III[1] site that is used for the storage of radioactive wastes from the Research Reactor, the Fuel Fabrication Building, and other institute facilities. The site contains an unloading structure, a storage area for low-level liquid wastes, a burial area for wastes mixed with concrete, and storage buildings for medium- and high-level wastes, isotopes, and highly enriched uranium (HEU) metals (95% enriched). The site is under 24-hour guard on foot patrol.

1.4 Protected Area

Ten buildings are located inside the PA perimeter. The Research Reactor Building is located near the center of the area. The Fuel Fabrication Building is located southwest of the Research Reactor Building. An Access Control Building (ACB) also straddles the northern perimeter and houses pedestrian and vehicular access control points (ACP), the CAS, and the Special Response Team (SRT) Ready Room. Material shipments are processed through the Shipping and Receiving Building, which supports both road and rail shipments. The Oxide Storage Bunker, located in the southeast corner of the PA, is used to store various enrichments of oxide powder for fuel fabrication. A full-service X-Ray Facility, located in the northwest corner of the PA, is used for fuel assembly quality control inspections. The PA also houses the Technical Area Administrative Annex I, Analytical Laboratory, Waste Measurement Facility, and Technical Area Cafeteria. Personnel offices are mainly located in Technical Area Administrative Annex 1 and the Research Reactor buildings.

The Analytical Laboratory is situated between Technical Area Administrative Annex I and the Waste Measurement Facility. The guard force responds to any alarms that occur in this area. Members of the guard force have a master key that allows them to enter and investigate the Analytical Laboratory after an alarm occurs.

[1] IAEA Categorization of Nuclear Material, from IAEA Nuclear Security Series No. 13, Category III, is unirradiated uranium of 10 kg or more of <10% ^{235}U, > 1 kg to <10 kg 10% to <20% ^{235}U, or >15 g but <1 kg ≥20% ^{235}U.

1.4.1 PA Perimeter

The PA perimeter has an isolation zone that comprises two chain-link fences that are 2.5 m high and 5 m apart. Guard towers are located at each corner just inside of the PA perimeter. These guard towers, which are manned continuously, are high enough for the guards to see all of the walls, the roof, and entrances of the Fuel Fabrication Building and the Research Reactor Building. The towers have 360-degree viewing windows made of high-strength window glass.

The area outside the perimeter has a 15-m cleared zone that is bounded by trees in several locations. The terrain is relatively flat.

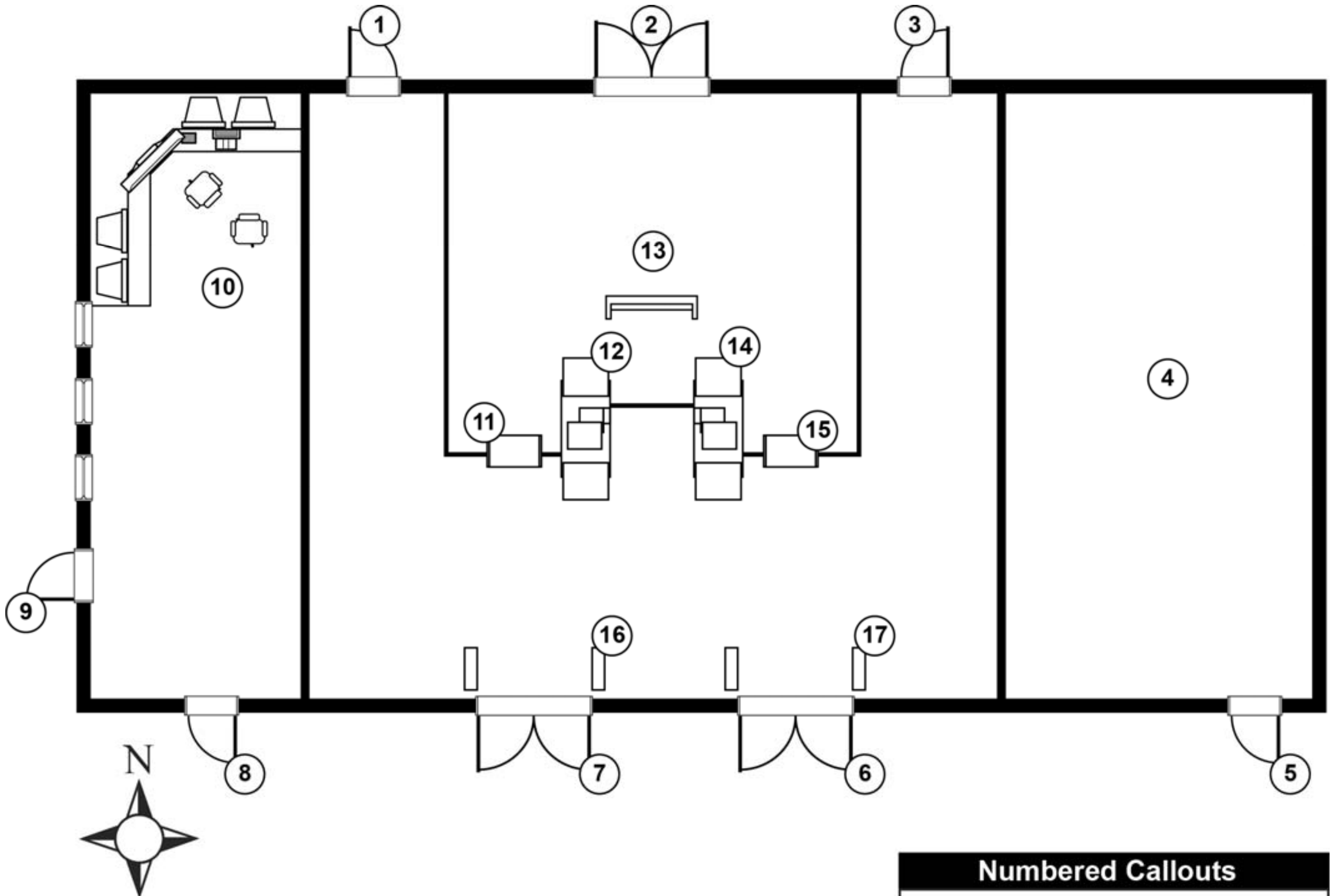
Patrols around the PA perimeter are conducted on the patrol road on a random basis. Patrols inside the PA perimeter are conducted by a guard on foot, also on a random basis. The lighting at the site is positioned around the perimeter of the entire site.

1.4.2 Access Control Building (ACB)

The ACB (#5 in Figure 1-2 and shown in Figure 1-3) houses the PA's personnel ACP, the CAS, and the SRT alert facilities. The CAS and SRT are in continuous operation. The ACP is open for normal entry during operational work hours (0700 to 1800), but the outer doors are locked during off-hours. The east side of the ACB houses a quick special response team of five persons, who respond to verified alarms in the area and provide key service to personnel needing access to normally locked areas. The northwest corner of the ACB houses the CAS, which is staffed by a senior guard and the guard supervisor.

The primary means for personnel and vehicle egress from the PA is through the ACB and its two vehicle portals. Vehicle entry through the PA perimeter is done through either the very important person (VIP) gate or commercial vehicle gate on either side of the ACB. The sliding gates are controlled from inside the ACB by one of the guards. Vehicle authorization is done by the guards with a visual recognition check. Personnel entry through the PA perimeter is done through the ACB.

Pedestrians enter the main door of the ACP in the ACB and present their site badges to one of the guards sitting at the desk. If the guard approves the entry, the authorized person passes through a metal detector, a radiation portal monitor, and on into the PA. All packages, purses, brief cases, lunch boxes, etc., pass through the x-ray detectors. The guard may also randomly perform a visual check of packages for contraband. The guards investigate any contraband noticed in the x-ray scan and respond to any metal detector or radiation portal monitor alarms.



Numbered Callouts

1. West Pedestrian Gate
2. Lobby Area Entrance
3. East Pedestrian Exit
4. Special Response Team (SRT) Alert Facility
5. SRT Alert Facility Entrance
6. East Pedestrian Entrance To Tech Area/ACP
7. West Pedestrian Entrance To Tech Area/ACP
8. Central Alarm Station (CAS) Entrance/Exit
9. Commercial Vehicle Entrapment Area Access
10. Central Alarm Station (CAS)
11. Metal Detector #1
12. X-ray #1
13. Security Receiving Area
14. X-ray #2
15. Metal Detector #2
16. Rad Detector #1
17. Rad Detector #2

Figure 1-3. ACB layout.

1.5 Research Reactor Building

The Research Reactor (#25 in Figure 1-2 and shown in Figure 1-4) is a light-water-moderated, HEU-fueled research reactor located within the SNRI. The reactor is used for research on advanced reactor components, special fuel assemblies, and the production of radionuclides for the medical industry. Other experiments are performed to investigate power reactor fuel when heated to the point of melting.

The reactor is not usually operated during the evening and off-shifts. During the off-shift periods, the gates and doors of the facility are locked and alarmed.

1.5.1 Reactor Data

- The pool-type research reactor is used in a steady-state operation of 10 MW.
- The core is located in an open pool that is 3.1 m in diameter and 8.5 m deep.
- The reactor is controlled by seven fuel-followed control rods with rod drive motors accessible.
- At least five control rods must be removed for the reactor to go critical.
- The annular core is formed by 240 cylindrical fuel assemblies arranged in a hexagonal grid around the dry central irradiation cavity that is 23 cm in diameter.
- Each assembly is 10 cm in diameter and 3.5 m long (the active element of the assembly is 1.25 m long).
- The assemblies consist of 10 fuel pins.
- Each fuel pin is ~1 m long, is 2 cm in diameter, weighs a total of 2 kg, and may be removed with a rigid fuel handling tool.
- Each fuel pin contains 103 g of ^{235}U.
- The fuel pins are composed of 105 pellets of ^{235}U enriched up to 36%.
- Each pellet contains 0.98 g of ^{235}U.

1.5.2 Cooling System

- The pool contains 62.5 m^3 of deionized water at a maximum temperature of 60°C.
- The core is cooled by natural convection in the water pool.
- A forced air/water heat exchanger is used to discharge the waste heat to the atmosphere.
- The heat exchanger is located inside the reactor building, with air ducts (and grids) running through the building walls.
- The reactor core is designed so that if a complete loss of water occurs after sustained 10-MW operation, air is sufficient for cooling. (However, natural circulation of air is essential.)

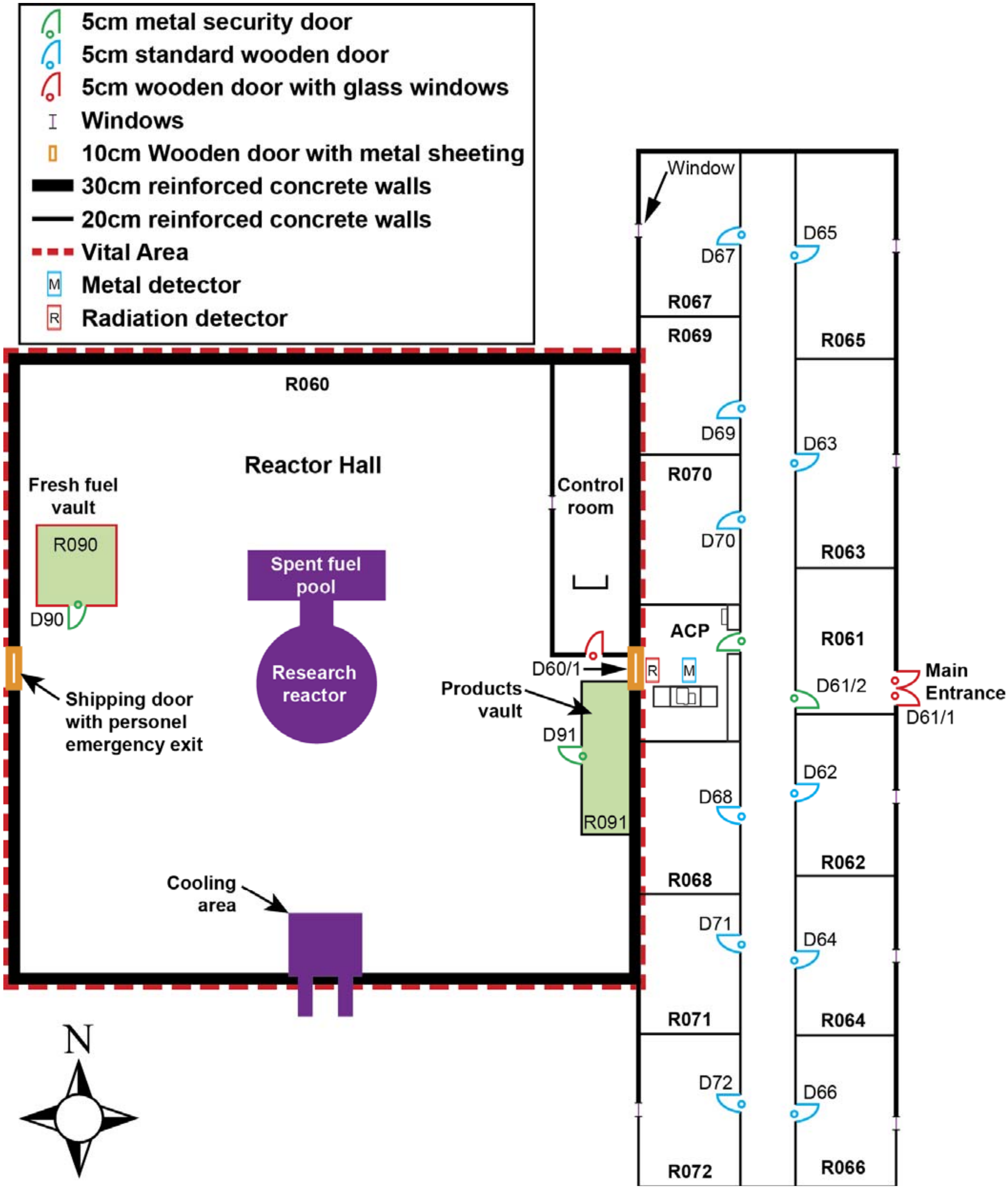


Figure 1-4. Research Reactor Building floor plan.

1.5.3 Irradiated Fuel Storage and Handling

- Irradiated fuel assemblies are transferred underwater to the spent fuel storage pools located in the Research Reactor Building.
- The assemblies are transferred in storage racks using rigid handling tools.
- The dose rate of freshly discharged spent fuel is ~0.2–0.3 SV/h (20–30 rem/h) at 1 m.
- Currently, 100 irradiated fuel assemblies are located in the spent fuel storage pools.
- The capacity of the storage pool is 300 fuel assemblies.

1.5.4 Fresh Fuel Storage and Handling

- Fuel pins arrive from the X-Ray Facility via intra-site convoy in shipping containers.
- Fuel pins for later assembly are stored in a reinforced concrete storage vault, R090, in the Reactor Building.
- Fuel storage racks capable of holding 10 fuel assemblies are used to transfer new fuel assemblies into the reactor pool.
- The storage vault can hold eight storage racks.
- A rigid fuel-handling tool is used to transfer the fuel assemblies to their intended position once they are placed in the reactor pool.
- Currently, 80 fresh fuel assemblies are located in storage.

1.5.5 Experiment Materials

- Experiment materials are located in R091 and include 23 kg of HEU metal in chips and pieces for experiments. The metal is stored in 3-liter containers on open shelves.
- Targets are used in other irradiation and activation experiments.

1.5.6 Entryways in the Research Reactor Building

The main pedestrian entrance allows access to the office areas and to the Reactor Hall's ACP. Emergency exits are located in both the administrative section (main entrance) and the Reactor Hall (shipping door). The Research Reactor Building has a shipping entrance to the Reactor Hall for receiving shipments of fresh fuel for storage in Room R090.

1.5.7 Research Reactor Building—Construction Details

Figure 1-4 outlines the construction details for the Research Reactor Building.

1.6 Fuel Fabrication Building

The Fuel Fabrication Building is located in the southwest corner of the PA (#26 in Figure 1-2). All uranium oxide fuel pins are fabricated within the Fuel Fabrication Building. This building is a multistory facility with a partial basement, ground floor, and mezzanine levels (shown in Figures 1-5 through 1-7). The partial basement holds the facility's system effluent discharge and storage/disposal area, the ground floor is the fuel fabrication area, and the mezzanine is the heating, ventilation, and air-conditioning (HVAC) area. The fabrication areas of the building are under negative pressure at all times. There are high efficiency particulate air (HEPA) and/or charcoal filters in this area to minimize plant particulate releases to the atmosphere.

The fuel fabrication process begins with the delivery of uranium dioxide (UO_2) powder of specified enrichments from the Oxide Storage Bunker. The UO_2 is stored in the Oxide Vault (#9 in Figure 1-5), until it is ready to use. The vault has a double lock requiring two people to open it. The canisters of UO_2 and depleted or natural uranium oxide powders are introduced to a glovebox entry point. A weighed amount of various enrichment UO_2 powder is placed in a ball mill jar to obtain the enrichment specification for the fuel pellets. Additives, such as organic binders and sintering aids, are added to the ball mill jar, typically <1 wt% of the uranium oxide powder. The powders are ball milled for many hours up to overnight. The powder is extracted from the ball mill jars and fed into the biaxial press to form green pellets, which are filled into trays and removed from the glovebox line.

The trays of pellets are placed on the conveyor belt to the sintering furnace. The pellets are sintered at high temperatures (~1700°C) under air, argon, and argon-hydrogen gasses. During the sintering stage, the organic additives are removed from the pellets and the pellets densify to close to the specifications for the fuel pellets (becomes a durable ceramic pellet). After sintering, the pellets are centerless ground to the exact specifications for the fuel pellets. Sintered fuel pellets are then sent to quality assurance (QA) for inspection, which includes elemental composition, uranium isotopics, pellet diameter, and inspection for chips and cracks. Pellets passing inspection are sent to the fuel pin assembly area (#10 in Figure 1-5) or placed in storage (#12 in Figure 1-5). Rejected pellets are ground into a powder, sieved, and recycled through the pelletizing operation. Powder from the centerless grinding operation is also recycled back into the pellet-forming operation.

The sintered pellets are made into fuel pins by stacking the sintered pellets into thin-walled tubes made of a zirconium alloy. The zirconium-clad pellets are then loaded into stainless-steel fuel pin assemblies (pins with end caps welded into place on one end of the pin). The pins loaded with fuel pellets have the second endcap assembly inserted; the pins then are backfilled with helium and tack welded. Pins that do not pass QA inspection are opened, and the fuel pellets are restacked into a new fuel pin.

The fuel pins are transferred to the X-Ray Building (#24 in Figure 1-2). After additional QA, the pins are transferred to the fresh fuel vault in the Reactor Building (R090 in Figure 1-4), loaded into assemblies, and stored for later use in the research reactor core. Every 18 months, one-third of the fuel pins is exchanged and placed in the cooling pond.

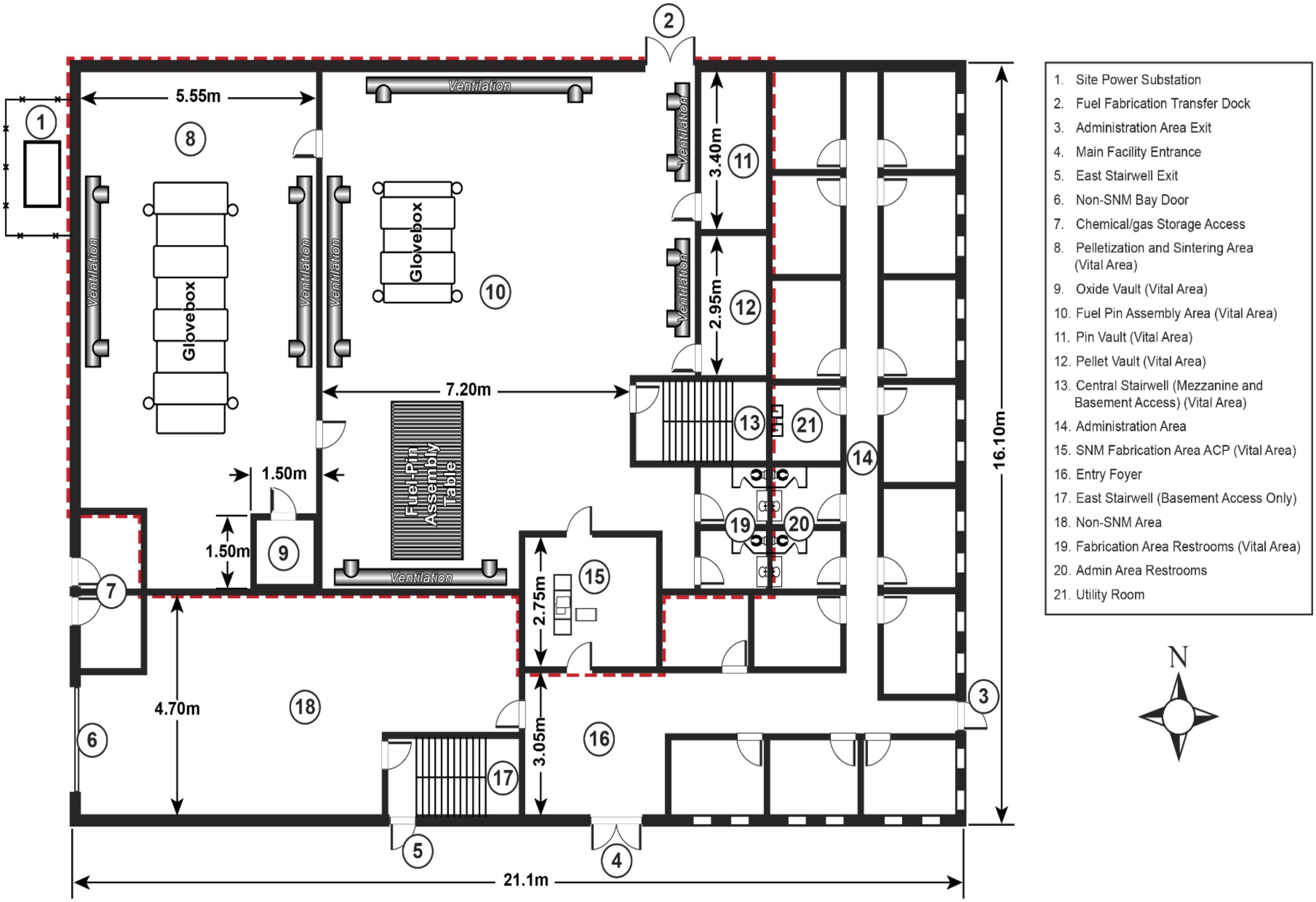


Figure 1-5. Fuel Fabrication Building floor plan.

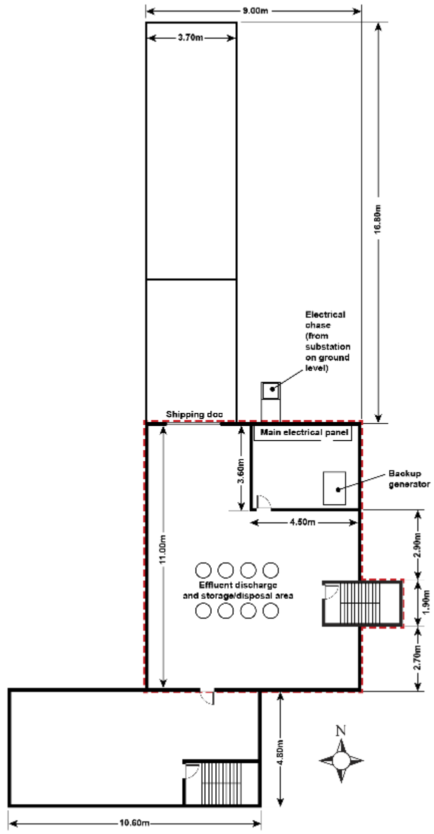


Figure 1-6. Fuel Fabrication Building (basement).

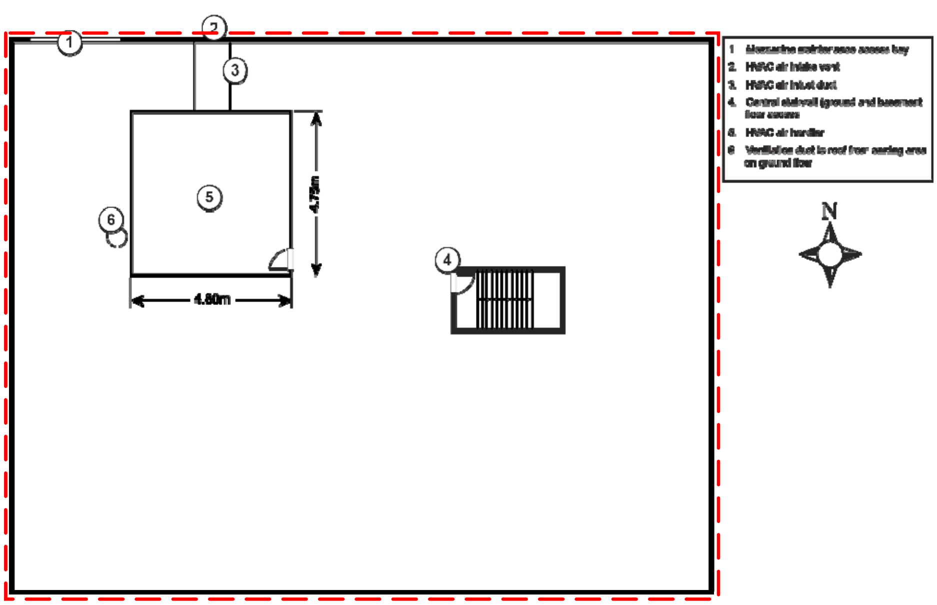


Figure 1-7. Fuel Fabrication Building floor plan (mezzanine).

The Fuel Fabrication Building houses the following areas/operations:

- Pelletization and Sintering Area (#8 in Figure 1-5)—has a series of connected gloveboxes that hold scales, ball mills, one bi-axial press, a centerless grinder, and inspection equipment. This area also has a belt furnace, which is not in a glovebox.
- Oxide Vault (#9 in Figure 1-5)—holds various enrichments (natural to 36%) of UO_2 in canisters awaiting pellet production. These oxides are classified by enrichment and stored in 3-liter stainless-steel cans. The amount of material in each may vary, but nuclear safety has established a limit of 4 kg of material in each can, regardless of enrichment. These cans are stored on open shelves in the vault.
- Fuel Pin Assembly Area (#10 in Figure 1-5)—holds a vibratory loader, stacking tray/tables, and an enclosed chamber for helium backfilling and welding.
- Pin Vault (#11 in Figure 1-5)—stores fuel pins with enriched uranium before they are sent to the X-Ray Building for inspection or to an approved off-site facility.
- Pellet Vault (#12)—holds sintered uranium oxide pellets awaiting final QA, as well as storage for pellets that have passed QA and are awaiting fuel pin assembly.
- Administrative Area (AA, #14 in Figure 1-5)—general office area.
- Non-Special Nuclear Material (SNM) Area (#18 in Figure 1-5)—used for receipt and inspection of nonnuclear materials. The area is also used for the initial assembly of fuel pins (i.e., the first endcap is welded on the fuel tubes). This area holds welding and inspection equipment.

1.6.1 Entryways in the Fuel Fabrication Building

There is a main pedestrian entrance to the building and shipping/receiving doors to both the nuclear material (NM) and nonnuclear material areas. The main pedestrian entrance (#4 in Figure 1-5) allows access to the office areas, the nonnuclear material area, and the fabrication area entry control portal (#15 in Figure 1-5). Pedestrians enter the main door and present their site badges to the receptionist at the desk. Emergency exits are located in both the administrative section and the fabrication areas. Two chemical/gases storage rooms can be accessed only from outside and share the loading dock for the nonnuclear material area. The Fuel Fabrication Building also has a shipping entrance to the partial basement that can be used for moving large equipment, as well as an overhead shipping door to the mezzanine with a crane attachment for moving HVAC units into the mezzanine. Grillwork over the duct ends on the mezzanine's outer surfaces protects the HVAC and filter system.

1.6.2 Fuel Fabrication Building—Construction Details

The emergency exit doors in the Fuel Fabrication Building are hollow-core metal industrial doors with panic hardware on the interior and a key lock on the exterior. The guards have the key to the lock for emergency response situations. The emergency exit doors are alarmed with a balanced magnetic switch (BMS). The main entry doors are glass, equipped with a BMS, and are set in a wall of windows. The foyer is used as a showcase to display information about the facility for visiting dignitaries. The exterior walls of the Fuel Fabrication AA are made of 20-centimeter (cm) (8-in.)-thick hollow concrete block. Each office has a window to the outside. The interior walls in the AA are typical sheetrock. There are no alarms in the offices or sensors on the office doors. The walls of the fabrication areas (pelletization, sintering, and grinding areas) are constructed of 20-cm (8-in.)-thick reinforced concrete. There are no windows to the outside in the fabrication areas. The roof in the fabrication areas is constructed of 14-cm (5.5-in.)-thick reinforced concrete on metal decking.

1.7 Shipping and Receiving Building

The Shipping and Receiving Building (#23 in Figure 1-2) is a one-story building with loading docks on both sides (one for rail shipments and one for trucks). Although several cubical office spaces located are inside, this building is basically an open warehouse.

1.8 Oxide Storage Bunker

The Oxide Storage Bunker (#20 in Figure 1-2) is used to store UO_2 of several enrichments, from depleted up to 36% ^{235}U, until needed for fabrication. The Fuel Fabrication Building personnel request a shipment of certain containers of UO_2 from the Bunker for its manufacturing operations. The building is fabricated of 3- to 4-ft-thick cement walls, has no windows, and has one door. The door requires SNRI personnel with two different access codes (or locks) to open. The Bunker has an IAEA Category I (≥5 kg uranium that is ≥20% ^{235}U).

1.9 Support Buildings

Three single-story support buildings are located east of the Research Reactor Building: Administration (i.e., offices) (#17 in Figure 1-2), the Analytical Laboratory (#18 in Figure 1-2), and the Waste Measurement Facility (#19 in Figure 1-2).

The Administration Building stores some classified material in safes, as well as the lock-and-key offices.

The Analytical Laboratory stores small quantities of NM in the form of process samples and reference materials. The first floor of the analytical laboratory is alarmed with a BMS sensor on the door and passive infrared (PIR) sensors, providing interior volumetric intrusion detection. The windows all have iron bars across them. The Analytical Laboratory is an IAEA Category III facility.

The Waste Measurement Facility stores NM in the form of waste drums.

2.0 Material on Site at the SNRI

Table 1 presents the SNRI material inventory.

Table 1. Nominal SNRI Material Inventory

Facility/ Material Balance Area	Location	Material Form	Material Amount (wt% Enrichment)	Total Isotope Amounts	Radiation Levels
Research Reactor	Reactor	UO_2 HEU Fuel Assemblies (240 in reactor)	686.4 kg U (36%)	247.2 kg ^{235}U	High >1 Sv/h at 1 m
	R090 Fresh Fuel Vault	UO_2 HEU Fresh Fuel Pins (80 assemblies in storage)	228.9 kg U (36%)	82.4 kg ^{235}U	Low
	Irradiated Fuel Pool	UO_2 HEU Irradiated Fuel Pins (100 in pool)	28.6 kg U (36%)	10.3 kg ^{235}U	High 0.2–0.3 Sv/h at 1 m
	R091 Product Vault	HEU Metal	23 kg U (95%)	22 kg ^{235}U	Low Low
Waste Storage Site	Tanks	Liquid Mixture (2 tanks, 1000 liters ea)	Trace Amounts of U (3%)	Trace	High 0.5–1 Sv/h at 1 m
	Small Buildings	Solidified Waste (50 containers)	Trace Amounts of U (4-10%)	Trace	High <0.5 Sv/h at 1 m
X-Ray Facility		Fresh Fuel Pins HEU Metal	8.6 kg U (36%) 5.2 kg U (95%)	3.1 kg ^{235}U 5 kg ^{235}U	Low Low Low
Waste Measurement Facility		Waste Drums	1 kg U	Trace	Low
Oxide Storage Bunker		UO_2 HEU	250 kg U (36%)	90 kg ^{235}U	Low
Fuel Fabrication Building	Oxide Vault Pin Vault Pellet Vault	UO_2 UO_2 UO_2 Green Scrap Sintered Scrap Grinder Sludge	94.5 kg U (36%) 69.5 kg U (36%) 69.5 kg U (36%)	34 kg ^{235}U 25 kg ^{235}U 25 kg ^{235}U	Low
Analytical Laboratory		Samples All Forms	1.1 kg U (36%)	400 g ^{235}U	Low
Shipping and Receiving Facility		Oxides and Hot Waste	See Section 2.10		Low

2.1 Input Materials

Input material consists of UO_2 from another plant that is shipped in by request. Input material is stored in the Oxide Storage Bunker until needed for fuel fabrication.

2.2 Material Flows

2.2.1 Fuel Fabrication Building

The annual throughput of the SNRI is ~1 metric ton of uranium of various enrichments. Uranium dioxide arrives from the Oxide Storage Bunker via intra-site convoy as oxide powder of various enrichments and is stored in the Oxide Vault of the Fuel Fabrication Building for future fabrication into fuel pins (see Figure 2-1). When a batch of pellets is needed for fabrication and none is available at the desired enrichment, a quantity of UO_2 is collected and batched according to the enrichment requirements. This weighing and batching of UO_2 is done in the Pelletization and Sintering Area outside the Oxide Vault. A technician takes canisters of the oxide powder from various drawers in the vault to make a batch of powder for pressing into pellets. The green pellets are sent directly to the Sintering Area for immediate sintering. The green pellets are sintered in the sintering furnace for 18 to 30 hours. Following the sintering process, the pellets are ground to the proper diameter using a centerless grinder. QA of samples for chemical analysis (i.e., destructive analysis) is performed, and the samples are sent to the Analytical Laboratory. Pellets are stored in the vault until it can be documented that they meet all fuel specifications. Once the QA analysis is complete and the pellets have passed inspection, they are transferred from the vault to the Fuel Pin Assembly Area, where they are formed into stacks and staged for loading into zirconium alloy fuel pins. The fuel pins undergo a leak check in the Fuel Fabrication Building; once they pass inspection, they are transferred via intra-site convoy to the X-Ray Facility for QA on the fuel pin welds. Fuel pins that do not pass inspection are returned to the Fuel Fabrication Building, where the pins are opened and the fuel pellets are removed for reloading into new pins. Fuel pins that pass QA are sent either to the Research Reactor Building (R090) or back to the Fuel Fabrication Building (Pin Vault) to be assembled into fuel assemblies and stored until they are shipped to an approved off-site facility.

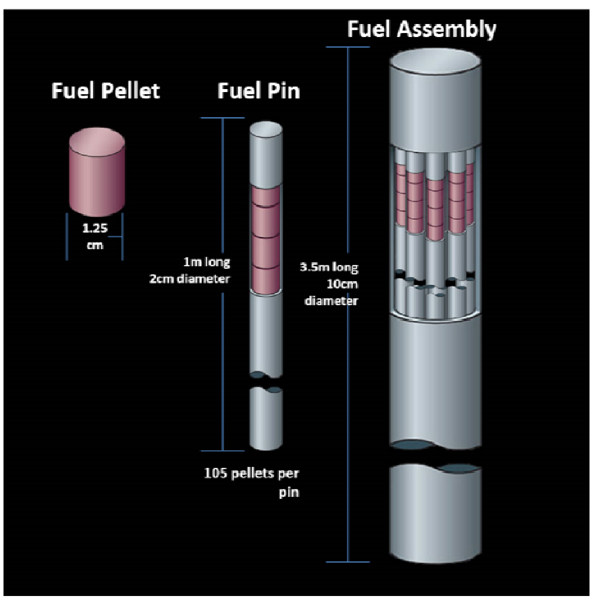


Figure 2-1. Fuel pellet, pin, and assembly.

2.2.2 Research Reactor Building

The Research Reactor Building uses and stores NM designated for use in the research reactor. Material is transferred into the building via intra-site convoy. Fuel pins are transferred from the X-Ray Facility, and other experimental material is transferred to and from the Shipping and Receiving Warehouse. Waste generated from the research is placed in appropriate waste receptacles and, when necessary, stored in R091 until it is collected for assay and transported to the Radioactive Waste Site.

2.3 Material Waste

Nuclear material in the form of waste is generated from various parts of the process. The fuel fabrication process generates both solid and liquid wastes at a rate of ~1% of throughput. Liquid wastes are described in Section 2.7. Solid waste is typically found in the form of rags, wipes, and gloves. Waste is collected and placed in waste receptacles. On a regular schedule, typically weekly, the operations support personnel collect and package the waste into waste containers. Once packaged, this material is moved on a biweekly basis to the Waste Measurement Facility, where the containers are assayed and the nuclear content is determined. Once the assay is completed, the waste packages are transferred to the Radioactive Waste Site at the northwest corner of the SNRI.

Hot waste, such as HEPA filters, is changed annually. The filters are removed from the glovebox, containerized, and sent to the Waste Measurement Facility for assay. Once the assay is completed, the waste packages are transferred to the Shipping and Receiving Facility for later transfer to the Radioactive Waste Site.

Clean waste (office type waste) is removed from the facility on a daily basis by operations support personnel. Waste is placed in dumpsters adjacent to the shipping dock. A local garbage contractor has been contracted on a biweekly basis to pick up clean waste and transport it to a local offsite dump for disposal.

2.4 Materials in Fuel Fabrication Building Vaults

The material in the Fuel Fabrication Building vaults is stored in various forms and quantities:

- The Oxide Vault holds various enrichments (natural to 36%) of UO_2 in canisters awaiting pellet production.
- The Pin Vault contains fuel pins awaiting shipment to the X-Ray Building or to an approved off-site facility.
    - Each fuel pin is ~1 m long, 2 cm in diameter, and weighs a total of 2 kg.
    - Each fuel pin contains 103 g of ^{235}U.
    - The fuel pins are composed of 105 pellets of ^{235}U enrichment up to 36%.
- The Pellet Vault contains sintered pellets awaiting QA for loading into fuel pins.
    - Each pellet contains 0.98 g of ^{235}U.

2.5 Materials in Fuel Fabrication Area

The amount of material exposed in the fabrication area at any one time in the material process can range from 5 to 20 kg but is only present during the normal 5-day work period. The material custodian has a schedule of work; once the fuel pin is assembled, the custodian picks up the product and delivers it to the Pin Vault. If a problem occurs in the process that delays the fuel pin's scheduled pickup time, the pin assembler notifies his supervisor, who then notifies the material custodian.

2.6 Materials Moved from the Fabrication Area

When the fuel pins are complete, they are sent via intra-site convoy to the X-Ray Facility for final QA. Material that has passed quality control is packed in a material container and either sent via intra-site convoy to the Fresh Fuel Storage Vault in the Research Reactor (Room R090) or sent to the Fuel Fabrication Building (Pin Vault) via intra-site convoy for assembly into fuel assemblies and then later shipped via inter-site convoy to an approved off-site facility.

Other materials moved from the fabrication area include analytical samples and waste. Analytical samples, in the form of sintered pellets, are transferred from the Pellitization and Sintering Area to the Analytical Laboratory as needed for each batch of fuel pellets. Nuclear waste is removed biweekly when the facility is operating.

2.7 Materials in the Fuel Fabrication Building Basement

The process to grind and polish the fuel pellets is aqueous. This process generates two types of aqueous waste: grinder sludge and liquid effluent. The grinder sludge is captured on the main floor and stored in buckets. The liquid effluent is captured and stored in several tanks in the basement. These tanks are emptied into drums when processing levels and/or safety concerns indicate levels have reached 20 kg. The drums may contain up to 2 kg of total uranium. The drums are transferred to the Radioactive Waste Site. Solid and liquid waste is generated at a rate of ~1% of throughput.

The system effluent discharge is stored in several tanks in the basement.

2.8 Materials in the Research Reactor Building

The Materials in the Research Reactor Building includes irradiated and unirradiated fuel pins in the reactor, fuel pool, and storage in R090. Additionally, HEU metal for experiments is stored in R091.

Fuel pins for the Research Reactor are obtained from the Fuel Fabrication Building and are stored in R090.

Irradiated fuel pins are transferred underwater to the spent fuel storage pool and remain until transported to another facility off site for reprocessing. Unirradiated fuel pins are transferred by hand to the access port of the reactor pool and attached to a rigid fuel-handling tool for movement through the pool and into position in the reactor.

Current inventory of material in the Research Reactor Building is provided in Table 1, Nominal Material Inventory.

2.9 Materials in the X-Ray Facility

An x-ray facility is available for performing x-ray analysis of fuel pins, which checks pin welds, and can also make sure the fuel pellets are still intact. X-ray and fluorescence analysis is also performed on samples from experiments brought from Room R091 in the Research Reactor Building. During a normal test, pins are in the x-ray facility for ~6 hours. When potential problems arise that need more investigation, parts can be left there overnight to preserve the diagnostic setup. When materials are left in the X-Ray Facility overnight, patrols place a seal on the door and check the seal every 30 minutes. The X-Ray Facility is constructed like a vault—

when material is left overnight, testing has determined that the material could be removed from the diagnostic test stand in ~60 seconds. Pins that do not pass the x-ray test are returned to the Fuel Fabrication Building to recycle the fuel pellets. Pins that pass QA are transferred via intra-site convoy to the Research Reactor Building or to the Fuel Fabrication Building (Pin Vault) for storage until shipped to an approved off-site facility.

2.10 Materials in the Shipping and Receiving Facility

Shipments of oxide and experimental materials for the Research Reactor are received via rail at the Shipping and Receiving Facility. Oxide powders are transferred to the Oxide Storage Bunker the same day they are received, but are often left in the shipping and receiving facility for 2 to 3 hours while the receiving paperwork is completed and weights, serial numbers, seals, and isotopic measurements are verified. While in the shipping and receiving facility (see Figure 2-2), material is constantly attended and is checked by patrols every 30 minutes. Materials in these locations are stored in 50-kg shipping containers.

Shipments of fuel pin assemblies to an approved offsite facility are also shipped from the Shipping and Receiving Facility. Fuel pin assemblies are packed in shipping containers. The containers are received from the Fuel Fabrication Building (Pin Vault) via intra-site convoy. Shipping paperwork is completed and weights, serial numbers, seals, and isotopic measurements are recorded and verified. Shipments are sent either via rail or vehicle convoy.

A section of the facility is designated for storing nuclear waste drums. These containers are received from the Waste Measurement Facility after they have been assayed. Waste materials may be stored from several hours to several weeks until a truck load quantity is accumulated.

Figure 2-2. Fuel assemblies awaiting shipment off site.

2.11 Materials in the Oxide Storage Bunker

The uranium oxide powder stored in the Oxide Storage Bunker (see Figure 2-3) consists of several enrichments (depleted to 36%) that have been received from an outside vendor/site. There is oxide in hermetically sealed 3 liter stainless-steel containers (4 kg) secured by two flip-up latches that are located on open shelves in the bunker. Criticality procedures dictate that only one 3-liter container can be stored per shelf. When shipped to the Fuel Fabrication Building, the 3 liter container is placed in a 5-kg intra-site shipping container with a spider that is secured by 3 flip-up latches. Material is also contained in the shipping containers from the Shipping and Receiving Facility. The material is packed in a primary hermetically sealed container which is placed in an outer shipping container. The outer containers consist of a heavy gauge steel drum that has a lid secured by six bolts. Each bolt has been tightened down to a specified bolt tension; each bolt has a tamper indicating device (TID) to indicate if any tampering has occurred. Inside the steel shipping container is the overpack, which is secured by two packing sleeves. The material container is a heavy gauge stainless steel container that also has a lid secured by six bolts. One of these bolts is sealed with a TID. The entire container weighs ~50 kg—the shipping container and the overpack weighs 35 kg, the packing material weighs 6 kg, the material container weighs 5 kg, and the material weighs 4 kg.

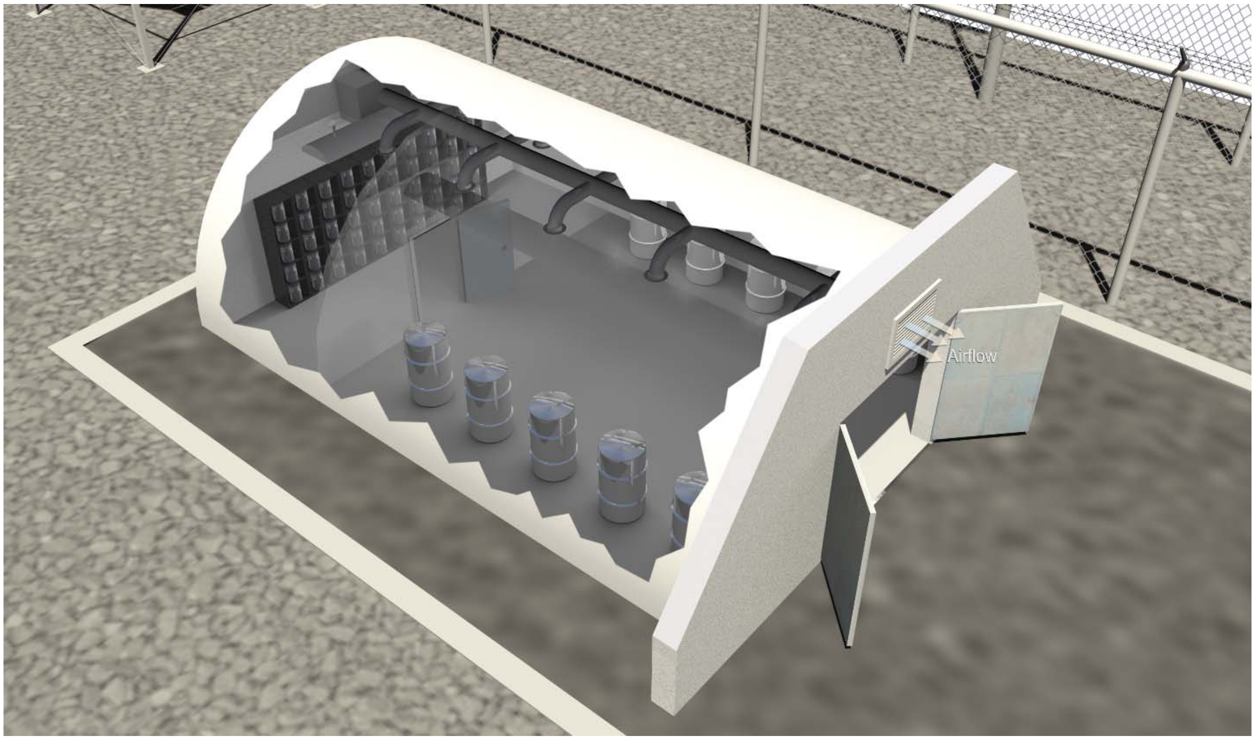


Figure 2-3. Oxide storage bunker.

3.0 Organization and Staffing

This section describes the organization and staffing levels of the SNRI to include the access, authority, and knowledge of facility employees and other vendors or inspectors who have routine access to areas within the SNRI PA. During normal operation, 205 full-time employees work at the site in plant operations, maintenance, engineering, technical support, management, and administrative support positions. Of the total number of employees, 160 require authorized access to the PA.

To be employed at SNRI, employees must undergo trustworthiness checks and be granted a security clearance based on the access required to perform their duties. The Republic of Anshar and SNRI have agreed to conduct the following checks in order to grant access to the facility:

Level 1: Identity, education, employment history, and financial history.

Level 2: Identity, education, employment history, financial history, criminal history. Security and intelligence agency check.

SNRI must update an employee's file every 5 years from the hire date or if there is a significant security incident or event during that 5 year period.

Some of the supervisors are also trained in SNRI's Behavioral Observation Program (BOP) which qualifies them to detect individual behavioral changes, which, if left unattended, could lead to threats to the safety or security of the facility or its employees. Identified individuals are offered appropriate support if they have job performance problems or exhibit unusual behavior.

Figure 3-1 shows the overall organization of the SNRI. Tables 2 and 3 show the distribution of employees by job category, their routine plant access and security clearance level, and their levels of authority and knowledge about plant operations.

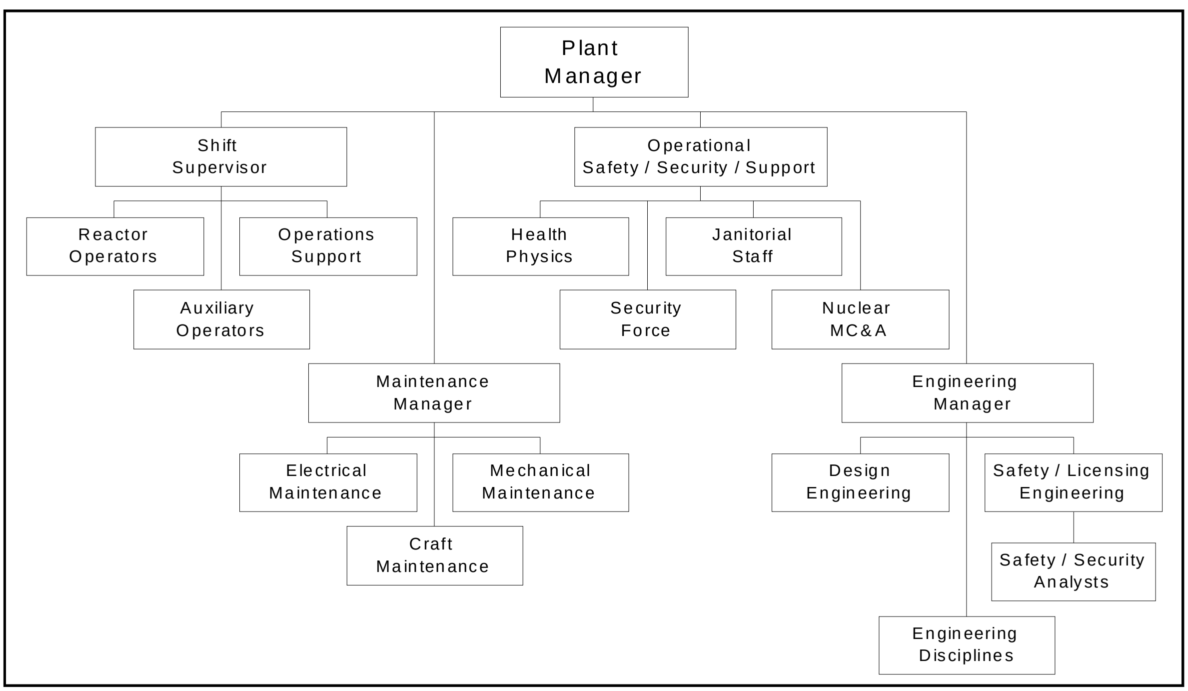


Figure 3-1. SNRI organizational structure.

Table 2. SNRI On-Site Staffing

Position (Number)	Authorized Access and Clearance Level	Authority/ Responsibility	Knowledge
SNRI Plant Manager (1) (Plant Manager Org.)	PA, Escorted Access to All Inner Areas[2] and Vital Areas, Level 2	• Overall direction • Not authorized to direct detailed facility operations • BOP Qualified	General knowledge of plant operations, lacks detailed understanding of facility
Shift Supervisor (3 total with 1 per shift) (Shift Supervisor Org.)	PA, All Vital Areas, Level 2	• Detailed direction of all facility activities. • Direction obeyed without question in most situations • BOP Qualified	Extensive, detailed knowledge about all aspects of facility design, layout, and operation
Reactor Operators (2) (Reactor Operators Org.)	PA, Reactor Hall, Level 2	• Detailed direction of all reactor operations	Extensive, detailed knowledge about all aspects of reactor design, layout, and operation
Pellet Technician (6 total with nominal 4 per day shift) (Operations Support Org.)	• PA, Fuel Fabrication Building, Level 2	• Detailed direction of all pellet fabrication activities • Under direction of shift supervisor	• Extensive, detailed knowledge about all activities in the pelletization area
• Pin Assembler (6 total with nominal 4 per day shift) (Operations Support Org.)	• PA, All Vital Areas, Level 2	• Detailed direction of all pin assembly activities • Under direction of shift supervisor	• Extensive, detailed knowledge about all activities in the fuel pin assembly area.
• Operations Support (6 total with nominal 4 per day shift) • (Operations Support Org.)	• PA, All Vital Areas, Level 2	• Perform specific operations tasks under direction of pellet technicians, pin assemblers, or reactor operators • Perform all material packaging and movements	• Specialized knowledge related to their duties, material packaging and movements, narrow knowledge of complete facility systems
• Maintenance Manager (3 total with nominal 1 per shift) (Maintenance Org.)	• PA, All Inner and Vital Areas, Level 2	• Overall direction to maintenance personnel • Perform activities on specific systems pursuant to work orders and the plan of the day • BOP Qualified	• General knowledge of plant operations
• Electrical Maintenance (6 total with nominal 4 per day shift) • (Maintenance Org.)	• PA, Escorted Access to Inner and Vital Areas, Level 2	• Perform activities on specific systems pursuant to work orders and the plan of the day[3]	• Specialized knowledge related to their duties, narrow knowledge of complete facility systems
• Mechanical Maintenance (6 total with nominal 4 per day shift) • (Mechanical Maintenance Org.)	• PA, All Vital Areas , Level 2	• Perform activities on specific systems pursuant to work orders and the plan of the day	• Specialized knowledge related to their duties, narrow knowledge of complete facility systems

[2] Inner Area is defined as an area with additional protection measures inside a protected area, where Category I nuclear material is used and/or stored. Vital Area is defined as an area inside a protected area containing equipment, systems or devices, or nuclear material, the sabotage of which could directly or indirectly lead to high radiological consequences.

[3] The plan of the day establishes the maintenance tasks to be performed each day and the systems to be removed from service for maintenance. The shift supervisor or his designee is required to be informed and provide authorization before a system is taken out of service for maintenance.

Position (Number)	Authorized Access and Clearance Level	Authority/ Responsibility	Knowledge
• Administrative support (40, all day shift) • (Operational / Safety / Security Support Org.)	• Administrative Areas, Access to PA requires escort, Level 1	• Administrative support	• No working knowledge of facility systems
• Master Locksmith (1), clerks (4) (all day shift) (Operational / Safety / Security Support Org.)	• PA, Escorted Access to all Inner and Vital Areas , Level 2	• Maintaining locks and keys	• No working knowledge of facility systems
• Health Physics Technicians (4 total with nominal 3 per day shift) • (Health Physics Org.)	• PA, All Vital Areas, Level 2	• Monitor radiological conditions • Not permitted to work on plant equipment	• Specialized knowledge related to their duties, narrow knowledge of facility systems
• Guard Supervisor (5 total, 1 at all times) • (Security Force Org.)	• PA, All Inner and Vital Areas, Level 2	• Direct activities of security force • BOP Qualified	• No knowledge of facility systems, but knowledgeable about plant security systems and security procedures
• Alarm Station Operators (5 total, 1 at all times) • (Security Force Org.)	• PA and CAS, Level 2	• Monitor alarms and direct response under the direction of the Guard Supervisor	• No knowledge of facility systems, but knowledgeable about plant security systems and security operational procedures
• Guard Technical Unit (3 total, minimum 2 per day shift and 1 all other times (Security Force Org)	• PA, All Inner and Vital Areas, Level 2	• Testing and Calibration of Physical Protection Equipment	• Specialized knowledge of the physical protection system (technology) and security procedures. No knowledge of facility systems.
• Patrol Guards (10 total, 2 at all times) • (Security Force Org.)	• PA, Level 2	• Routine patrol of PAs and non-radiological areas and respond to plant alarms	• No knowledge of facility systems, but knowledgeable about plant security systems and security operational procedures
• Post and tower Guards (34 total, 8 during the day shift, and 6 all other times) • (Security Force Org.)	• PA, Level 2	• Staff access control and other security posts and respond to plant alarms	• No knowledge of plant safety / operational systems or plant response to abnormal conditions, but knowledgeable about security operational procedures

Position (Number)	Authorized Access and Clearance Level	Authority/ Responsibility	Knowledge
• Special Response Team (25 total, 5 at all times)	• PA, All Inner and Vital Areas, Level 2	• Respond to alarms in vital and inner areas	• No knowledge of plant safety / operational systems or plant response to abnormal conditions, but knowledgeable about security operational procedures
• Security Analysts (2)	PA and CAS, Level 2	• Perform security analysis activities and review performance and status of specific systems	Specialized knowledge related to design and performance of security systems
Janitorial Staff (9 total, 5 during day shift and 2 at all other times) (Janitorial Staff Org.)	Administrative Area, PA, and Escorted Access to Inner and Vital Areas, Level 1	• Cleaning and housekeeping	No knowledge of plant systems or security measures
Material Control Manager (1) [material control and accounting (MC&A) Org.]	PA, All Inner and Vital Areas, Level 2	• Detailed direction of all MC&A personnel • BOP Qualified	Extensive, detailed knowledge about all aspects of MC&A movements, inventory, computerized accounting data
Measurement Control Coordinator (1) (MC&A Org.)	PA, All Inner and Vital Areas, Level 2	• Detailed direction of Nuclear Material Technicians	Extensive, detailed knowledge about plant inventory, measurement, and error limits of all DA and nondestructive assay (NDA) instruments
Material Balance Area Custodians (6 total, day shift) (MC&A Org.)	PA, All Inner and Vital Areas, Level 2	• Direct NM inventories, authorize transfers	Knowledgeable about NM status and inventory procedures, but no knowledge of facility systems
Nuclear Material Technicians (2 total) (Nuclear MC&A Org.)	PA, All Inner and Vital Areas, Level 2	• Perform NM operations and inventories at the direction of Material Balance Area (MBA) custodians	Knowledgeable about NM status and inventory procedures, but no knowledge of facility systems
Nuclear Material Accountability Technicians (2 total) (Nuclear MC&A Org.)	Administrative Areas, PA, All Inner and Vital Areas, Level 2	• Maintain paper accountability system and generate required NM status, transfer, and inventory reports	Knowledgeable about NM status and inventory procedures, but no knowledge of facility systems
Engineering Support (3, all day shift) (Engineering Manager Org.)	Administrative Areas, PA, Level 2	• Support plant engineering activities	Specialized knowledge related to their duties
Design, Mechanical, Electrical, Civil, Chemical and Nuclear Engineers (5, all day shift) (Design Engineering & Engineering Discipline Orgs.)	Administrative Areas, PA, Level 2	• Perform design activities and review performance and status of specific systems	Specialized knowledge related to design and performance of specific plant systems, moderate knowledge of complete facility systems
Safety Engineers, (2 on day shift) (Safety / Licensing Engineering Org.)	Administrative Areas, PA, Level 1	• Analyze safety and impacts of proposed changes, develop / review procedures and procedure revisions, prepare documents for State regulator	General knowledge of performance and roles of facility systems, but no detailed knowledge of operation of complete facility systems

Position (Number)	Authorized Access and Clearance Level	Authority/ Responsibility	Knowledge
Computer/Network Engineers, (2 on day shift) (Engineering Org.)	Administrative Areas, Access to PA requires escort, Level 2	• Support computer networks, maintain computer/network security.	Specialized knowledge of the computer systems, no knowledge of facility systems.

Table 3. Vendor or Inspector Access to SNRI

Type	Routine Access	Authority / Responsibility	Knowledge
Vendors	Administrative Area, No Security Clearance	• No authority over plant employees	No knowledge of plant systems, plant response to abnormal conditions, or security measures
Railroad Personnel	Escorted access in the PA, no access to vital and inner areas, No Security Clearance	• No authority over plant employees	No knowledge of plant systems, plant response to abnormal conditions or security measures
State Safety/Security Inspectors	Employee escort required for all access, Level 2	• No direct authority over plant employees; however, suggestions are given great weight	General knowledge of performance and roles of facility systems

4.0 SNRI Material Control and Accounting System

4.1 MC&A Organization

By letter of designation, the plant manager has delegated the responsibilities and authorities of all safeguard positions. A single individual is assigned the responsibility for technical coordination of the overall MC&A programs. This position is referred to as the Material Control Manager for all NM. This position is separate from production and any other responsibilities that might give rise to a conflict of interest. In addition, there is a Measurement Control Coordinator and multiple MBA Custodians assigned specific authorities, responsibilities, and locations reporting directly to the Material Control Manager.

4.2 Material Balance Areas

The SNRI has eight MBAs. The MBAs are the Research Reactor (MBA #1), the Radioactive Waste Site (MBA #2), the Waste Measurement Facility (MBA #3), the Oxide Storage Bunker (MBA #4), the Fresh Fuel Fabrication Building (MBA #5), the X-Ray Facility (MBA #6), the Analytical Laboratory (MBA #7), and Shipping and Receiving Facility (MBA #8). All accountable NM at the SNRI is maintained in one of these eight MBAs. Non-accountable NM in the form of waste can be present in the Waste Measurement Facility, the Radioactive Waste Site, and the Shipping and Receiving Facility. The physical boundaries of the X-Ray Facility, Analytical Laboratory, the Oxide Storage Bunker, and Waste Measurement Building MBAs are the structural boundaries of their respective building. The physical boundaries of the Research Reactor Building and Fuel Fabrication Building MBA are the walls and access control points for the respective buildings. The physical boundary for the Radioactive Waste Site is the fenced area that encompasses this area of the SNRI site.

4.3 Measurements and Measurement Control Program

This program is under the control of the Measurement Control Coordinator (MCC). The measurement control program ensures the quality and reliability of the measurement data. This program incorporates the following measurement control elements:

- various mass stations for weighing
- destructive analysis laboratory
- NDA measurement systems
- weekly calibration of measurement equipment or operability checks with reference standards
- a sampling program
- Statistical control programs associated with all measurement systems to ensure the quality of data generated (to ensure there are no biases in the measurement data)

The MCC maintains the equipment and standards in a locked room in the Analytical Laboratory and is responsible for the proper use and calibration of the equipment. The MCC also tracks measurement data and performs statistics to verify that the equipment is running without biases. Any nonfunctioning measurement equipment is identified and locked out or removed from service by the MCC. Only the MCC can verify the equipment

In addition, the MC&A organization controls and issues TIDs for use throughout the SNRI facilities. MBA Custodians are the only personnel trained to apply and remove TIDs.

4.4 Key Measurement Points

NM measurements may take place at several key measurement points (KMPs) (see Table 4) located at MBAs. Material is normally measured on the following occasions:

- within 2 days of receipt;
- for internal transfers between MBAs, depending on whether the mass limit exceeds 2 kg;
- when modifications are made to the material's physical form in the fabrication process;
- as part of item monitoring along the process path; and
- as waste containers are generated and staged at the Waste Measurement Facility.

Table 4. KMP Information

			Error	
Material Strata	KMP	Measurement Method	Random	Systematic
UO_2 Powder	KMP-1	Powder Scale	20.0 g	10.0 g
		Sample	0.002	0
		Gravimetric	0.0006	0.0002
Sintered Pellets	KMP-2	Pellet Tray Scale	10.0 g	5.0 g
		Sample	0.0021	0
		Gravimetric	0.00009	0.00002
Dirty Powder	KMP-3	Scrap Scale	10.0 g	5.0 g
		Sample	0.033	0
		Titration	0.023	0.0014
Green Scrap	KMP-4	Scrap Scale	10.0 g	5.0 g
		Calculation	0.00144	0.00006
Sintered Scrap	KMP-5	Scrap Scale	10.0 g	5.0 g
		Sample	0.033	0.019
		Gravimetric	0.00061	-0.0002
Grinder Sludge	KMP-6	Scrap Scale	10.0 g	5.0 g
		Sample	0.035	0.02
		Titration	0.03	0.01
Liquid Waste	KMP-7	Drum Scale	50.0 g	25.0 g
		Sample	0.04	0.02
		Fluorimetric	0.251	0.02
Solid Waste	KMP-8	NDA Gamma	0.1	0.25
Reject Pins	KMP-9	WT/factor	0.3 g	0.2 g

4.5 Physical Inventories

A physical inventory (PI) is conducted in each MBA every two months under normal conditions. The physical inventory consists of a 100% inventory of items or containers with TIDs and measurement of a statistical sample of items. The measurements are NDA measurements and the attributes are compared to the book values. Discrepancies are tracked in the measurement control system. If a measurement is beyond the control limits for that measurement from the recorded value, the item in question is subjected to additional confirmatory measurements, including opening the container and, if required, conducting destructive measurements.

Data obtained during the physical inventory, data from measurements during the material reconciliation period, and control program data are used to calculate the Limit of Error of Inventory Difference (LEID). Special inventories are conducted when custodial responsibilities are changed, items are believed to be missing, inventory differences exceed established control limits, and other abnormal occurrences take place. These special inventories may be limited to a single vault or MBA, depending on the occurrence. However, the facility may be impacted depending on the circumstances. Investigation of inventory differences between accounting records and physical inventory results will be performed to determine the cause. Table 1 (Section 2.0) above shows the Nominal Nuclear Inventory.

4.6 Shipping and Receiving

Items received are booked on shipper's values for element and isotope content. When shipments are received, the item count and item identifiers are verified against the shipping documents. If a discrepancy occurs, the item will be quarantined until the discrepancy can be resolved. The Material Balance Custodian records shipper values for items that are shipped to an approved offsite facility.

4.7 Item Monitoring

In addition to the fixed periodic physical inventories, the process area has further designated several Inventory Control Locations (ICLs), which provide the capability to physically locate (or confirm the location of) items in a timely manner. This capability to localize losses (or thefts) of NM allows for the identification of the mechanism for any such loss (or theft) in a more time-sensitive manner. Process boundaries are selected primarily on the basis of manufacturing control; however, this division also enables managerial assignment of specific material handling and control responsibilities, if required.

4.8 Adjustments to Inventory

Adjustments are made to inventory on the basis of the measurements at the KMPs (see Table 4). Accountability values for oxide and pellets are based on DA or weight. Inventory is adjusted for the difference between the measured input versus the final accountability weight. Adjustments are also made based on waste that is removed from the fuel fabrication process as established by NDA in the Waste Measurement Facility.

4.9 Accounting Reports

SNRI submits material balance reports for each MBA within 30 days of completion of a physical inventory. Nuclear material transaction reports for the MBA covering all transactions during the inventory period are submitted with the material balance report. SNRI provides a telephone report to the State Regulator within 4 hours of determining that an item cannot be accounted for or an unresolved weight discrepancy exists in the bulk process. This report is followed up with a written report within 24 hours of this determination.

4.10 Accounting System

SNRI enforces a separation of duty policy by employing a computer-based accounting system that is managed and operated by personnel who are not authorized hands-on access to NM. The computer on which the accounting system is operated is a standalone machine. Entry of or access to accounting data or modification of the accounting software requires authorization via a password system. All data is input to the SNRI computer accounting system from paper records (*e.g.*, inventory sheets and material transfer forms), which are uniquely numbered, accounted for, signed by the individuals completing them, and retained for the life of the plant. The SNRI accounting software is commercially procured and is not modified by plant staff.

4.11 Material Control

Physical control of the material is established through several individual programs. Access controls limit personnel access to the Oxide Storage Bunker, Fabrication Area and areas within the Research Reactor Building and additional access controls further limit personnel access to the Products Vault (Room R091) and the Fresh Fuel Vault (R090) in the Research Reactor, as well as the Oxide Vault, Pin Vault, and Pellet Vault in the Fuel Fabrication Building. Procedural measures in the Oxide Storage Bunker, Research Reactor, and the Fuel Fabrication Building limit access to material to those with an established need for access. The MBA Custodians for the various locations authorize all material movements. Material access is further enforced through the use of the two-person rule. Any time a material location is accessed or material is being used for fuel fabrication or experiments, two persons must be present.

Transfers of samples to the Analytical Laboratory and waste to the Waste Measurement Facility are handled by Operations Support Personnel. Since these are Category III and less quantities, the two person rule is not applied.

4.12 Data Control

SNRI has two network/computer engineers that are responsible for maintaining computer networks and computers. The server room is located in the Administrative Annex 1 (located within the PA). All back-up tapes are stored in this room as well. These are the only persons with administrative rights.

4.13 Personnel Access Control at Protected Area ACP

4.13.1 Entry Process

Personnel entering the PA must process through the ACP in the ACB. The ACP is open from 0700 to 1800 Monday through Friday. Authorized personnel enter the area through the middle double doors to the ACP. Personnel must present their badges to the guard for picture identification. Once cleared, hand-carried items are placed in plastic bins that are processed through the x-ray machine. Personnel then proceed through a metal detector. If they trigger an alarm, they may walk back through the metal detector, search themselves to determine what caused the alarm, place that material on the x-ray belt, and walk through the metal detector again. If they do not trigger another alarm, they may collect their materials and proceed to the radiation portal monitor. If they set off the metal detector a second time, they must be searched by the guards with a hand-held unit. The guards also monitor the x-ray video for contraband. Personnel then proceed to the radiation portal monitors. If the radiation portal monitors alarm when personnel are passing through them to enter the area, the person is stopped and questioned regarding possible reasons the alarm might have sounded and, if necessary, Health Physics is called to check the equipment.

There are three guards at the ACP to process personnel.

4.13.2 Exit Process

Personnel exiting the PA enter the ACP through the double doors and pass through the radiation portal monitor. If they do not set off the alarm, they continue through the exit doors (east and west). If there is an alarm, the guards will stop the person passing through the radiation portal monitor and, if necessary, call the Health Physics personnel, who will respond to determine the cause of the alarm.

4.13.3 Entry into Fuel Fabrication Building

The ACP for entry into the Fuel Fabrication Building is similar to the protected area ACP and contains the same equipment (although the metal detection threshold is lower).

4.13.4 Entry into Research Reactor Building

The ACP for entry into the Research Reactor Building is similar to the protected area ACP and contains the same equipment (although the metal detection threshold is lower).

4.13.5 Contraband Detection Equipment

All contraband detection equipment and alarm equipment at the ACPs is maintained and tested by the technical unit of the guard force. The x-ray and metal detection equipment is function-tested every shift. The guard supervisor walks through the metal detection portal (with his sidearm) to ensure that it alarms and will run a test item (such as a step wedge) through the x-ray detector to check the operability of the x-ray system. Since access to a test source requires the coordination of the Health Physics or MC&A staff, the radiation portal monitors are functionally tested via the self-test button (which only tests the light and tone alarms).

The contraband detection equipment is performance-tested on a monthly basis. A special test item kit is used to test the metal detector. This kit contains sealed weapons that bound the less detectable, commercially available handguns. Two technicians from the technical unit perform the test; one passes the units through the field at specific locations, and the other reads through the test procedure and records results. The sensitivity of the x-ray unit is tested with a test kit containing various synthetic explosive materials, various gauges of wire, and various shielding materials. If any equipment is found to fall below specified performance specifications, the equipment is readjusted per the manufacturer’s instructions and tested again. The radiation portal monitor is also checked at this time. The Health Physics personnel bring a radiological check source (Cobalt-57 and Cesium-137) and take it through the radiation portal monitor in several configurations (near the top, near the middle, and near the bottom). The Health Physics personnel make any required adjustments to the equipment since the technical unit of the guard force does not receive training in nuclear detection equipment. However, someone from the technical unit must be present while the Health Physics personnel make these adjustments.

The radiation portal monitor controls and sensitivity adjustment are contained in a locked panel on one side of the monitor. The head of the Health Physics Department locks the key in a safe in his office. The unit is wired to the security power system for the CAS which has an uninterruptible power supply (UPS) and a generator backup. The alarm for the unit is local with a light and tone alert. The metal detector sensitivity adjustment and controls are located in the top panel of the unit. There is a key pad for user input and a code is used to access the setup and adjustment menus. If the supervisor code is entered, several basic sensitivity programs that come with the unit from the factory can be selected with one key stroke. These units are also wired into the CAS power system. The alarm for these units is local and consists of an alarm tone and a light bar indication of alarm strength. Due to overrunning the capacity of the CAS power system, the x-ray units are powered by normal facility power. Sensitivity adjustment control is through software with a password required for access to any operation other than normal screening. A trained operator must watch the screen to notice if contraband is passing through the system. There is no automatic alarm indication.

If a system malfunction is noted in the daily report, it is required to be worked on within 24 hours. During normal operating hours, there are always two technicians available to ensure adequate oversight of repair work. On weekends, a guard watches over the work since there is usually only one technician available. After any maintenance or repair work, the system is tested by the technician and then is put back into service.

4.13.6 Intrusion Detection Systems

The technical unit of the guard force is also responsible for testing intrusion detection systems in place at the site. The critical intrusion detection systems are tested monthly (*e.g.*, in the vaults) and other systems are tested quarterly on a rotational basis. All tests are carried out according to procedures and associated schedule that the Guard Force Supervisor approves annually. BMS testing is considered to be completed by normal opening of doors for routine activities and is not specifically tested in the scheduled tests. The testing performed on a regular basis is classified as operations testing and is done to determine how the sensors detect people approaching a target. The technicians perform the walk test on interior sensors by starting at a logical starting point (*e.g.*, a door or window) and progressing toward the target until an alarm is signaled. This is repeated at least ten times and at least once from all possible entry locations. Any missed detections are reported to the Guard Supervisor and evaluated for appropriate compensatory measures and corrective action. If the problem is from the equipment or furniture in the detection area, the occupants will be contacted and will work with the technical unit to resolve the issue. If the blocking items cannot be moved, more detectors may be installed.

Two members of the technical unit conduct the tests—one reads through the procedure and record results while the other performs the walk test. Two members of the technical unit will also be on hand for any repairs to ensure oversight of repair work. Once repairs are made, the system will be functionally-tested by the technical unit and turned over to the CAS.

All intrusion detection systems have an installed battery backup power system and are connected to a stand-by generator. A fully charged battery powers the intrusion system for at least ten minutes which is sufficient time for the generator to get to operating speed and start providing power. Backup batteries are checked when the systems are functionally-tested. Generators are tested every three months on weekends by facilities management personnel.

All intrusion alarm communications wiring is run in conduit and has line supervision. All junction boxes are either sealed or have tamper switches. The data-gathering panels are locked with a special key controlled by the Guard Supervisor. They are also protected with tamper switches which alarm at the CAS.

4.14 Lock and Key Control

The technical unit is also charged with installing locks, making keys, and changing combinations. One master locksmith and several clerks assist with key control. The office for the lock unit is in Administrative Annex 1 (located within the PA). All combinations and key blanks are stored in a safe. Records of keys and work requests and completions are kept on a computer in the office. Only the master locksmith and the clerical staff have the password to the system. Keys for office doors, building doors, and padlocks are cut on a special key blank registered to the site. There are not supposed to be any master keys. Once a certain number of keys have been lost (greater than 5%), all locks are re-cored with a new keyway. All combination locks have the combinations changed at least annually. However, the combination is changed immediately if there is a change in personnel.

4.15 Badge and Visitor Control

The site uses a badge printing process that prints directly on plastic badge stock. A background has been designed and a tamper-resistant overlay has been provided for all national sites to use. Although each site has a special alpha-numeric identifier that shows where the particular badge was issued, the badges are designed to allow access at all affiliated sites. Different colors around the border of the badge signify different access authorizations including a designation for material handlers. A legend of these designators is posted in access control points to quickly resolve any questions regarding access.

The badge office (in the Administrative Building outside of the PA) prints all employee and visitor badges for this site. Badge stock is locked in a safe in the badge office when it is not occupied. The computer used for printing badges and maintaining the badge database is networked to a computer in the CAS. The CAS has access and can view all badges that are issued by the badge office.

5.0 SNRI Physical Protection System

5.1 Operations at Gates and Portals at the SNRI

5.1.1 Site Personnel and Vehicle Entrance

Personnel are permitted access through an access control point after verification that they have a current site badge. The guard controlling access is required to verify that the picture matches the badge holder and that the badge has not expired or been revoked. There is Badge Office in the Administration Building that issues permanent and temporary badges for access to the plant. Exiting personnel are not checked.

Vehicles authorized routine entry to the site are provided with decals. The security officer(s) on duty permit vehicles to enter upon verifying the vehicle decal and the badges of all vehicle occupants. Temporary vehicle passes may be obtained at the Administration Building with appropriate authorization from site management.

When a delivery vehicle arrives, the guards review the manifest and shipping documents to verify that the truck has a delivery for the institute. The guards then contact the recipient of the delivery to verify that it is expected. Once this is done, the guards search the truck for contraband. If the delivery vehicle passes inspection, it is permitted entry to the site. Exiting vehicles are not checked.

5.1.2 Protected Area Vehicle Gates

These gates are normally closed and locked with high-security padlocks. When a vehicle arrives, an ACP guard verifies that the driver either has an SNRI badge permitting access to the SNRI PA, or has the required escorts. Once the guard has verified that the delivery is expected, the guard searches the vehicle for contraband. If the vehicle passes inspection, the guards contact the CAS to indicate an authorized alarm will be received. The guards then unlock the vehicle gates to permit the vehicle entry to the SNRI PA. After the vehicle has entered the PA, the gates are locked.

Upon exit, vehicles are scanned with a radiation monitor to ensure that there is no contamination and are searched for NM. Once guards verify that the vehicles are not contaminated and do not have unauthorized NM, the vehicles are permitted to exit. The guard contacts the CAS to indicate that an authorized alarm will be received. The contamination scan and NM search are performed inside the PA with the vehicle gates locked.

5.1.3 Protected Area Personnel Access Control Point

Personnel entering the PA undergo a search for contraband by passing through metal, explosive, and radiation detectors. Hand-carried items are x-rayed and passed through metal detectors. Suspicious items are physically searched. Individuals who fail the metal detector search are either searched again with a hand-held metal detector or are subjected to a pat-down search. The guards who perform the badge checks have a “panic” button that will freeze the doors and preclude any entry to the PA. In a site emergency, the doors can also be reconfigured to permit egress from the PA to facilitate evacuation. The layout of the access control section of the SNRI PA access control point is shown in Figure 5-1.

Personnel exiting the PA undergo a search for NM by passing through a radiation portal monitor. If they do not set off the alarm, they continue through the exit doors (east and west). If there is an alarm, the guards will stop the person passing through the radiation portal monitor and call the Health Physics personnel, who will respond to determine the cause of the alarm

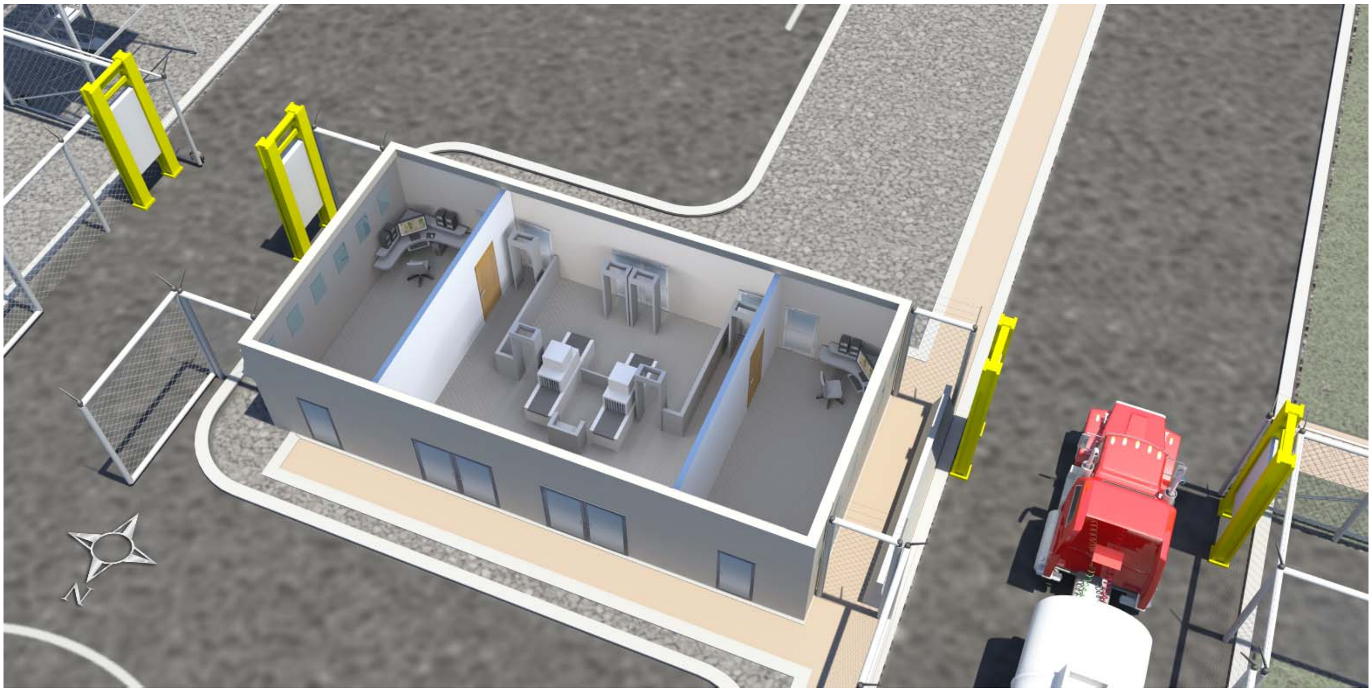


Figure 5-1. PA Access Control Building.

5.1.4 Fuel Fabrication Area ACP

The SNRI Fabrication Area includes the controlled areas within the Fuel Fabrication Building where a Category I quantity of NM is accessible. The ACP for entry into the Fuel Fabrication Building is similar to the protected area ACP and contains the same equipment (although the metal detection threshold is lower).

5.1.5 Research Reactor ACP

The ACP for entry into the Research Reactor Building is similar to the protected area ACP and contains the same equipment (although the metal detection threshold is lower).

5.2 Physical Barriers and Alarms

The SNRI Site is surrounded by an unalarmed 2.5-m-high chain-link fence to delineate the legal boundary and keep out trespassers. The SNRI PA is surrounded by two 2.5-m-high chain-link fences with an alarmed isolation zone between the two fences.

5.2.1 Area-Specific Access Controls and Physical Barriers

Table 5 presents a list of access controls and physical barriers.

Table 5. Access Controls and Physical Barriers

Controlled Area	Access Controls	Physical Barriers	Detection Devices
AA	Employee badge	Chain-link fence; vehicle gate	Guard checks
PA	ACP	Perimeter Intrusion Detection and Assessment System	Perimeter sensors; tower guards
ACP	Employee badge with guard present to ensure correct procedures at metal detectors and NM detectors	Security doors; walls	Guard; metal detectors and radiation portal monitors
X-Ray Facility	2-person control on locks	Vault-like construction with Class V doors	BMS door sensor; interior PIR sensors
Oxide Storage Bunker	2-person control on locks	Vault-like construction with Class V doors	BMS door sensor; interior PIR sensors
Fuel Fabrication Building	Entry control portal	Security doors; substantial walls around fabrication area; office area with windows; guard	Metal and radiation portal monitors
Fuel Fabrication Vaults (oxide, pin, and pellet)	2-person control on locks	Vault-like construction with Class V doors	BMS door sensor; interior microwave sensors
Research Reactor Building	Entry control portal	Security doors; substantial walls around reactor; office area with windows, guard	Metal detectors
Research Reactor Vaults (Rooms R090 and R091)	2-person control on locks	Vault-like construction with Class V doors	BMS door sensor; interior PIR sensors
Radioactive Waste Site	Locked gate	Chain-link fence; vehicle gate	Guard; Health Physics Check

5.2.2 Probabilities of Detection

Table 6 presents the probability of radiation detection estimates.

Table 6. Radiation Detection Probability of Detection Estimates

Radiation Detection Estimates	Probability of Detection
Vehicle	0.5
Personnel using Portal	0.85
Personnel using handheld device	0.75

6.0 Response Forces at the SNRI

Table 7 presents the SNRI response force details.

Table 7. SNRI Response Forces

Types of Response Force Personnel	The response force consists of two types of onsite security personnel: • Unarmed guards • Armed guards, including tactical response teams
Responsibilities of Response Force	These security personnel are responsible for: • assessment of alarms • administrative duties, such as access control and key service • routine patrol and staffing of fixed posts • response to all security alarms • observe adversary actions and communicate them to the alarm station All posts and patrols have defined policies and procedures with which the guard force must comply.
Supervisors	For each shift, one supervisor is present to supervise the guards that conduct administrative duties, patrols, and intrusion alarm response.
Equipment: Unarmed Guards	All **unarmed guards** are equipped with: • a straight baton • one set of handcuffs • a small flashlight • a handheld radio
Equipment: Armed Guards	All **armed guards** are equipped with: • an automatic pistol with a fully loaded magazine • two spare magazines of ammunition • a straight baton • one set of handcuffs • a small flashlight • a handheld radio
Equipment: Special Response Team	The special response team members are equipped with: • an automatic pistol with a fully loaded magazine • an automatic assault rifle with a fully loaded magazine • two spare magazines of ammunition for each weapon • a straight baton • handcuffs • flashlight • handheld radio • body armor is readily available in the response force vehicles
Central Alarm Stations and Communication	The **CAS** is staffed by a minimum of one guard at all times. This guard is responsible for the assessment of alarms and communication to the response force. The security force supervisor is routinely at the CAS. The CAS is equipped with: • 100-watt radios that can communicate to all posts and patrols within the boundaries of the Institute • 2 telephone lines—one is linked to each fixed post via a buried telephone cable and the second is a direct link to the offsite response force located in the city All hand-held radios and fixed posts are equipped with a duress switch to allow sending the CAS a covert signal of unauthorized activity. When the CAS receives a duress alarm, the special response team is contacted.
Security Force Deployment	The response force is deployed as described in Table 9 below. The security posts and site layout are illustrated in the area diagrams.

Table 8 presents the data for response force deployment at various locations.

Table 8. Response Force Deployment Data

Post No.	Description	No. of Guards	
		Day Shift	Off-Shift
P-1	CAS (includes commander) (unarmed)	2	1
P-2	Site Personnel and Vehicle Entrance	2	0
P-3	PA Commercial Vehicle Gate	1	0
P-4	PA VIP Gate	1	0
P-5	PA ACP	2	1
P-5	Fuel Fabrication Facility ACP	2	1
P-6	Research Reactor ACP	1	0
P-7	Rail Gate ACP	On call	0
P-8	Roving Patrol inside SNRI (unarmed)	2	2
P-9	Special Response Team	5	5
P-10	Guard Technical Unit	2	1
	Totals	**20**	**11**

Response Process	All alarms are received at the CAS. For alarms that cannot be assessed via closed-circuit television, the CAS operator dispatches the nearest available guard to assess the alarm. If the assessment indicates a situation that cannot be handled by a single unarmed guard, the CAS operator dispatches additional guards.

Table 9 presents average response force times for various alarm locations.

Table 9. Average Response Force Times

Alarm Location	Response Time[4]
PA Fence	30 seconds – 2 minutes
X-Ray Facility	30 seconds –- 2 minutes
Oxide Storage Bunker	30 seconds – 3 minutes
Reactor Building, Vaults, Experiment Room	30 seconds – 2 minutes
Fuel Fabrication Building, Fabrication Floor	30 seconds – 2 minutes

[4] The variation in response times reflects the varying locations from which guards may be dispatched to respond to the alarm.

7.0 Other General Information

7.1 Threat Data

- There have been some internal disputes over labor issues at the SNRI in the past five years.
- Two institute employees were recently caught stealing equipment and were terminated from the facility.
- Local reports of upcoming layoffs at the plant have recently been announced in the local news.
- Items were recently confiscated from a political terrorist group's hiding place, which was located <200 km from the SNRI. The items included internal engineering drawings of the SNRI with circles drawn around the Oxide Storage Bunker; various weapons, including automatic weapons; some explosives; and evidence of correspondence and communication with a foreign terrorist group. Interviews with property owners and residents indicated the group consisted of three to five men.
- Intercepted communications from a neighboring country indicates that a large terrorist group has tried to acquire a large quantity of NM.
- Surveillance of several members of the terrorist group shows extensive travels in and out of the country.
- Plans by a political terrorist group to attack shipments of NM in a neighboring country were discovered.
- The national intelligence organization reports terrorist groups are operating in cells of four to six individuals and compartmentalizing information.
- A major bank robbery was committed in the capital 2 months ago. Four robbers escaped with a large amount of money. Investigation shows that the bank vault was breached by the sophisticated use of high explosives stolen from the local army base.